LBNE

Fermilab | U.S. DEPARTMENT OF ENERGY

Simulation of energy deposition in the LBNE absorber

Summer student meeting

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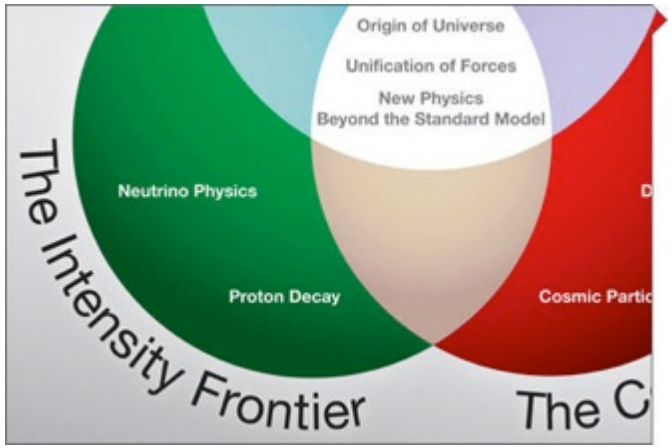
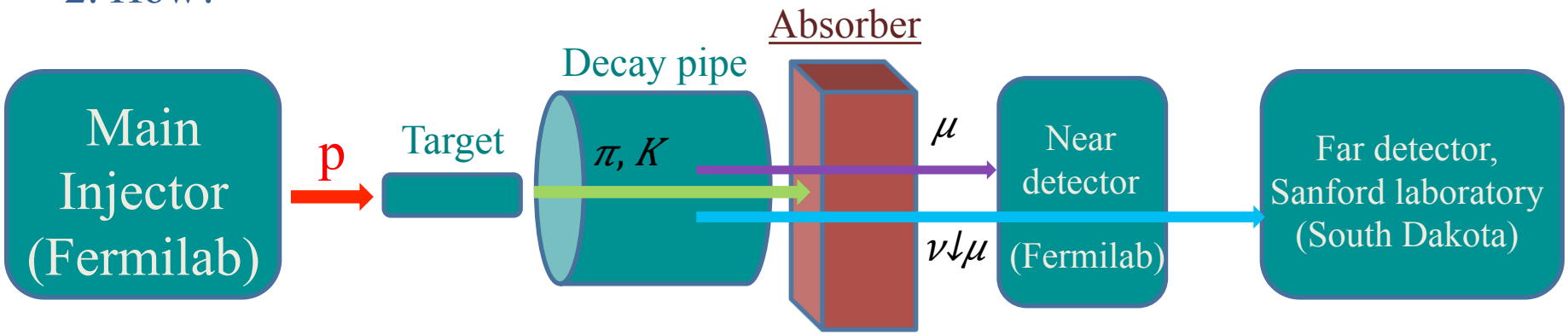
Long-Baseline Neutrino Experiment (LBNE)

1. Why?

For precise measurements of important neutrino properties (e.g. mass hierarchy and CP-violation) in order to test our understanding of neutrinos and their role in the Universe



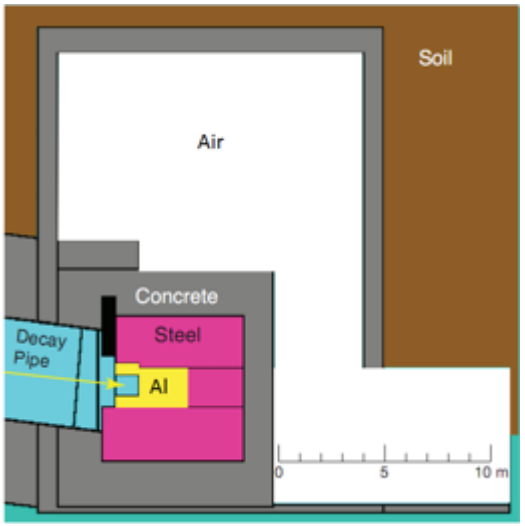
2. How?



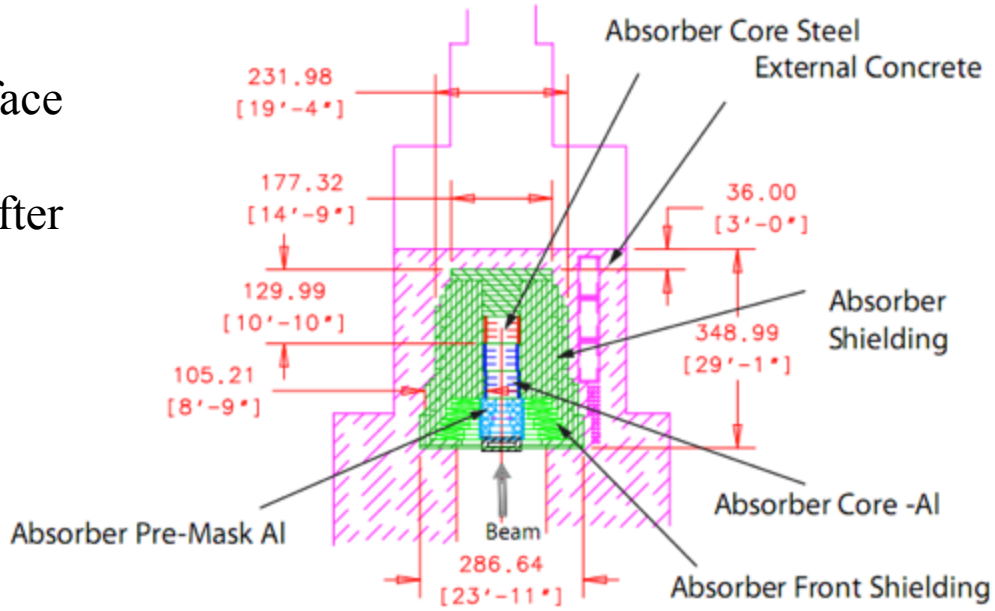
Hadron absorber

Absorber role:

- Prevention of activation subsurface soils, groundwater and air
- Absorption of residual particles after the decay pipe



Simplified elevation view of absorber within absorber Hall



Model of the absorber conceptual design

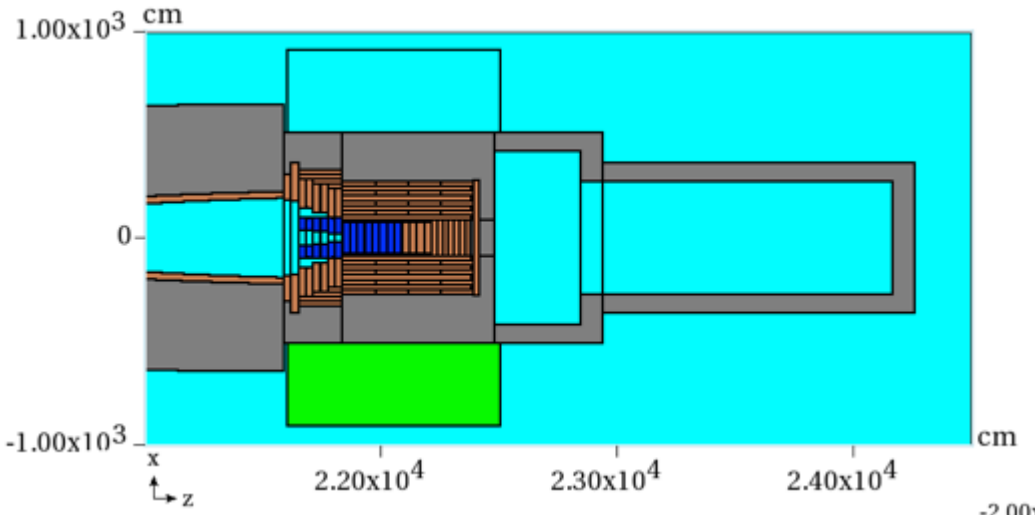
Main parts of absorber:

- Core (aluminum, steel) – water-cooled
- Shielding (steel, concrete)
- Temperature monitoring and cooling infrastructure

Goals

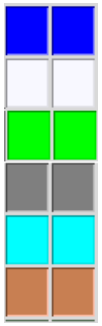
1. Describe structure of the absorber using the ROOT graphic interface
2. Simulate energy deposition in water-cooled parts of the absorber utilizing the MARS code system
3. Optimize design of the absorber according to the following requirements:
   - Prevention of the activation of subsurface soil, groundwater and air;
   - Operation without maintenance at beam power 2.3 MW and energy of p+ 60-120 GeV during the lifetime of experiment
   - Dissipating 570 kW/beam spill at 2.3 MW beam power

Model of the absorber



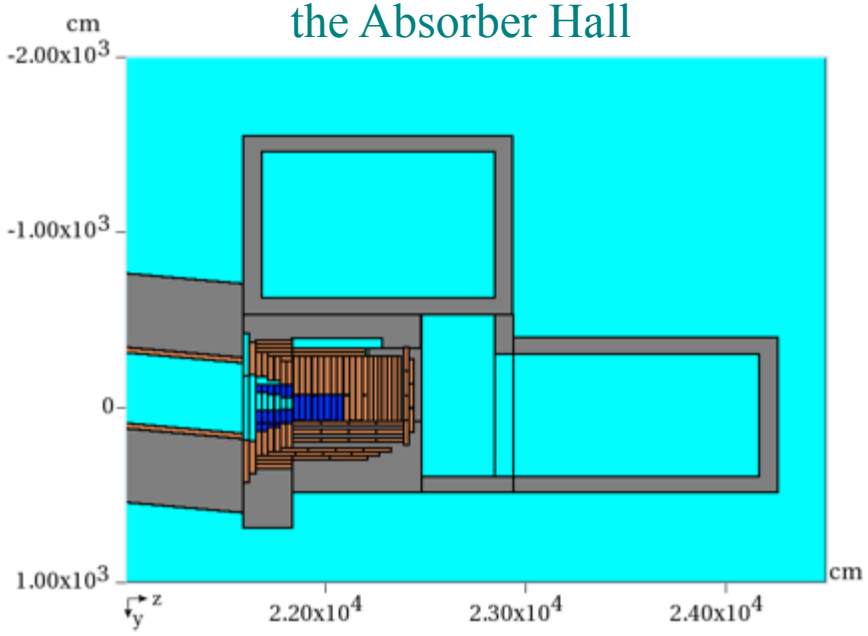
Horizontal central section of the Absorber Hall

Materials:



Aluminum
Vacuum
Soil
Concrete
Air
Steel

Vertical central section of the Absorber Hall



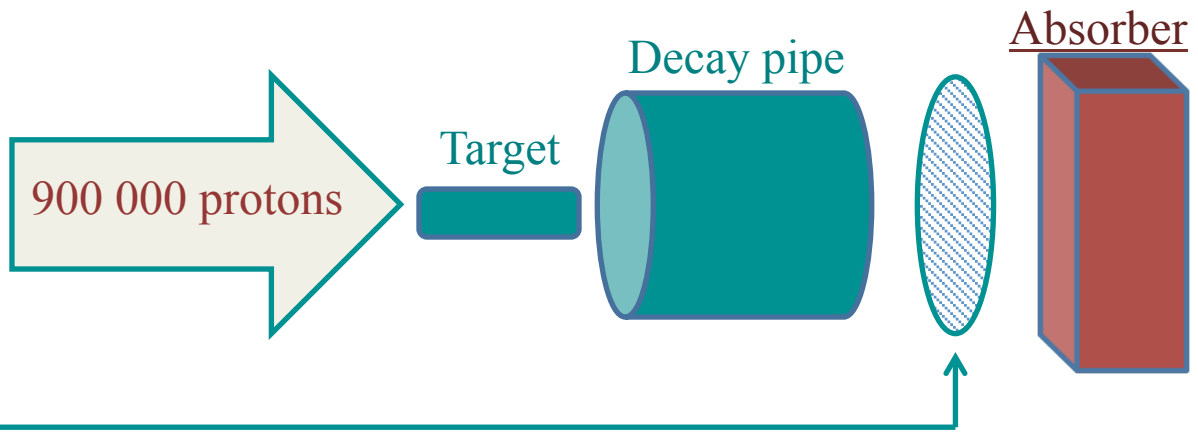
Model features:

- Include Service facilities and Decay pipe
- Consist of slabs and blocks placed accurately according to Reference Design
- Technical gaps 0.3 - 1 cm between parts
- Water lines inside water cooled parts

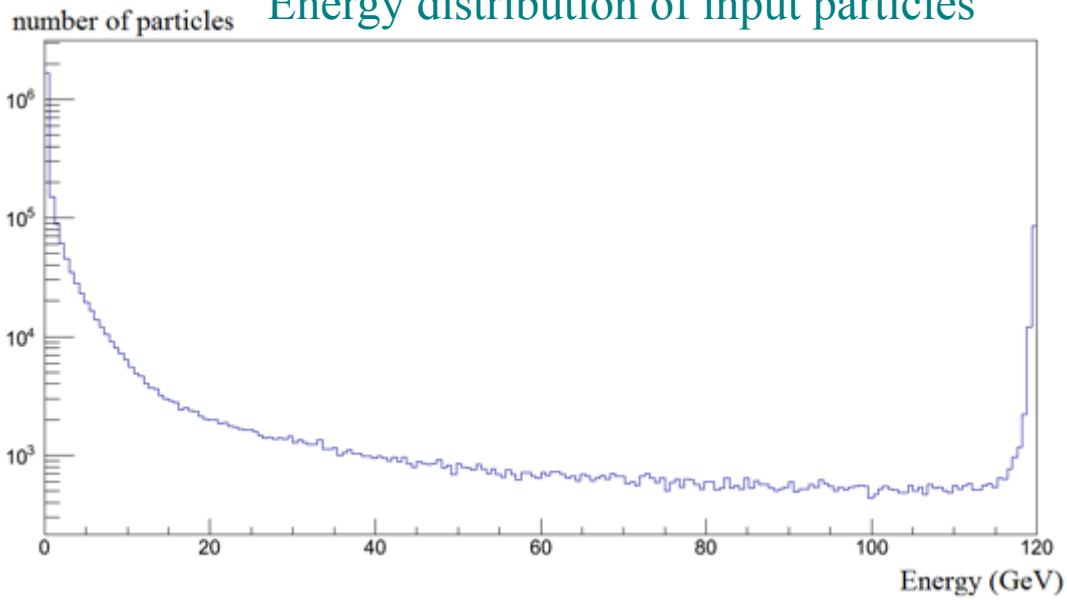
Input of simulation

Input surface and particles:

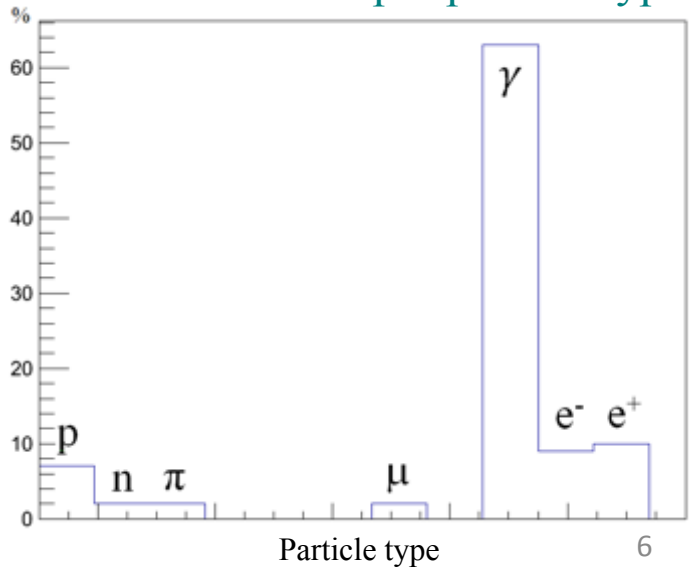
- End of decay pipe
- | r | < 230 cm
- 2.4 mil secondary particles
- > 60% γ
- 20% e+, e-
- ~7% initial p
- 5MeV energy cut-off



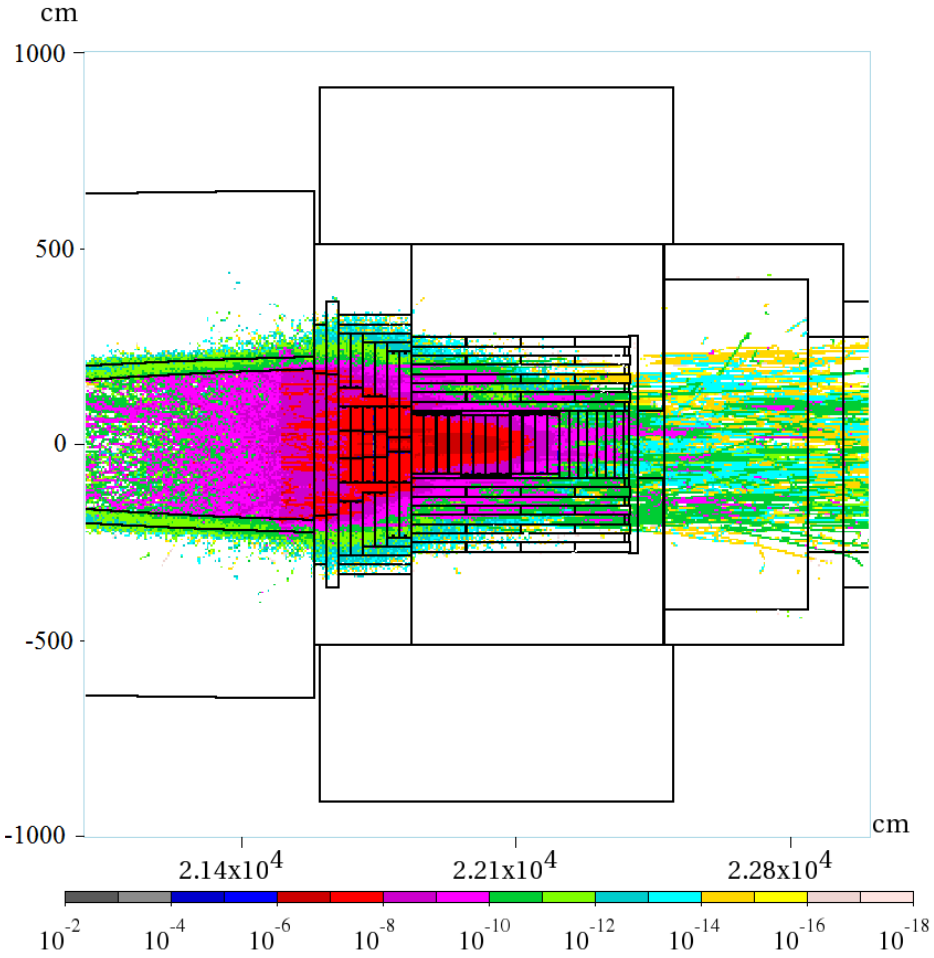
Energy distribution of input particles



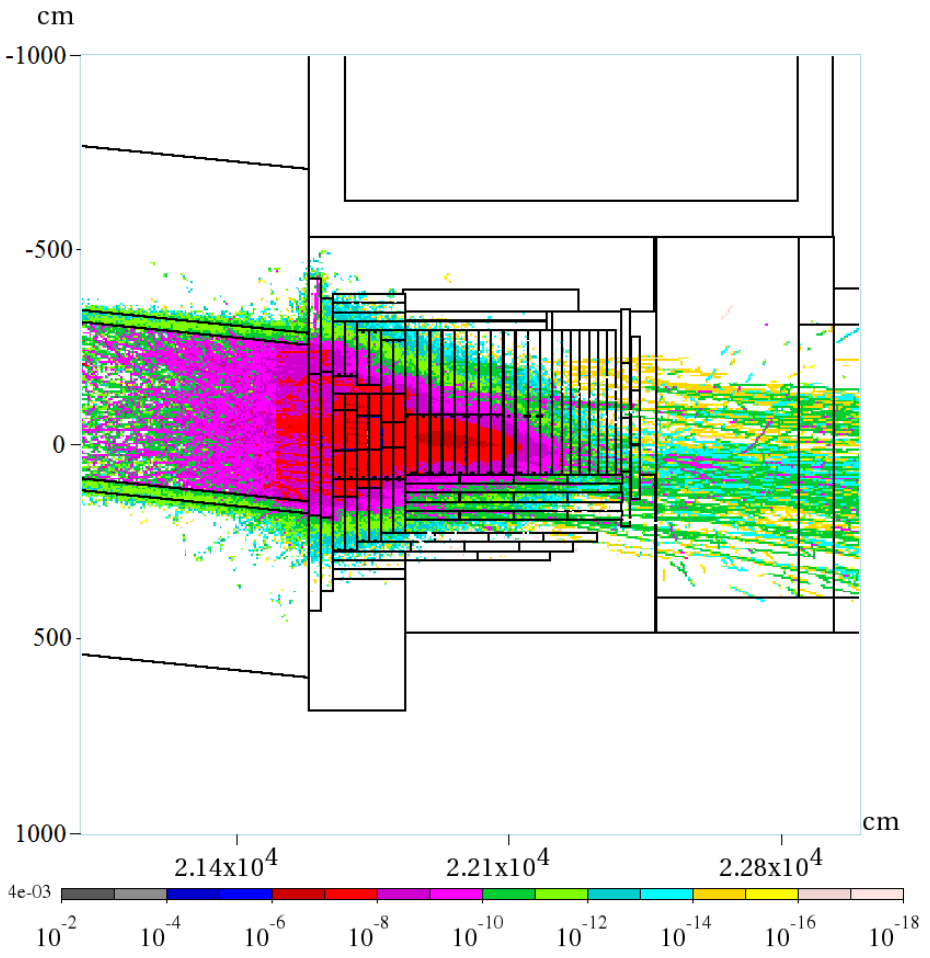
Distribution of input particle types



Output of simulation – energy deposition



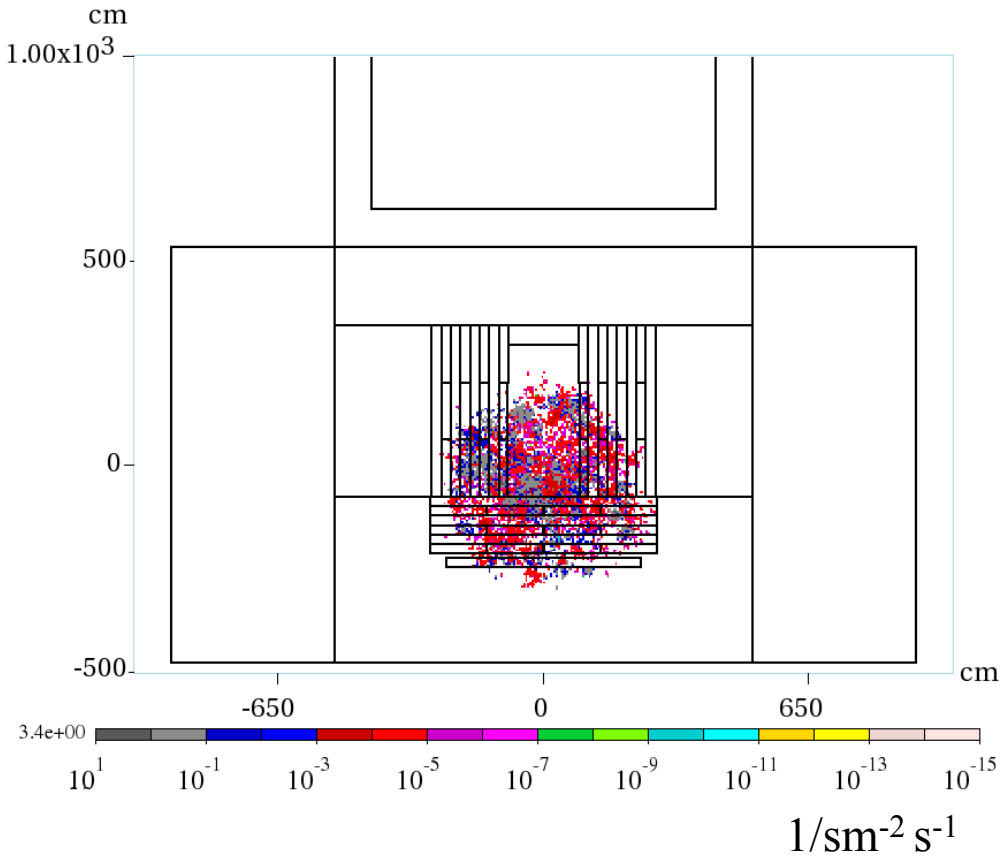
Horizontal section mW/g



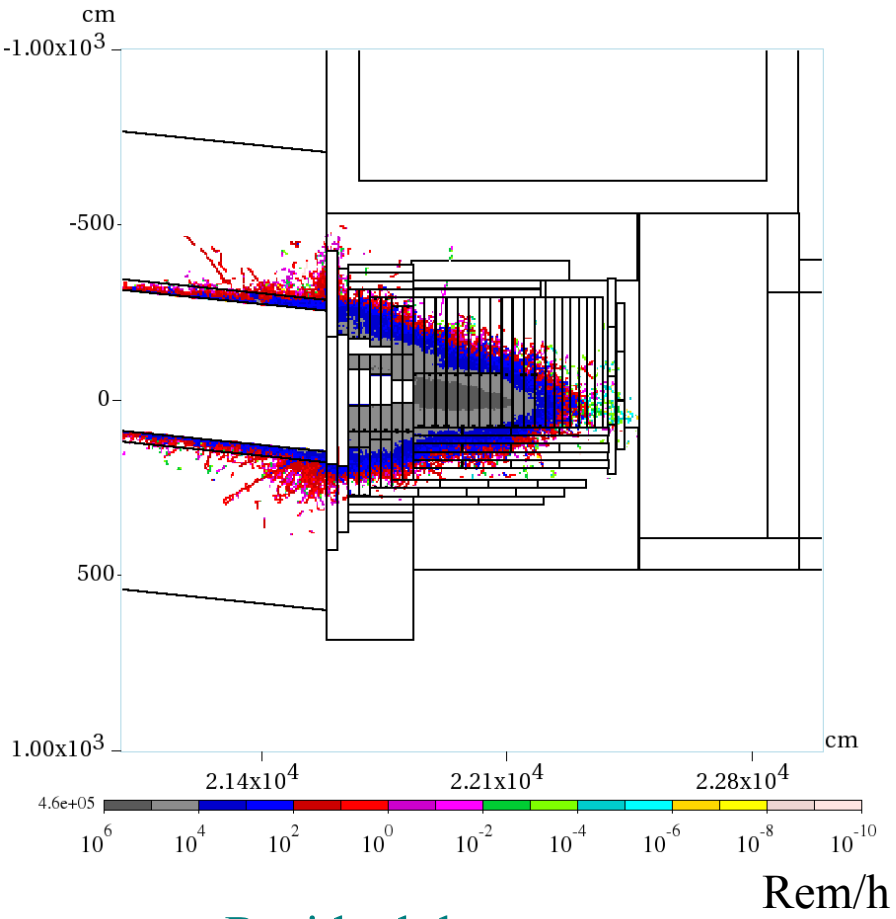
Vertical section mW/g

Energy deposition in the absorber (mW/g per 1 secondary particle)

Output of simulation – other quantities



Muon flux at the back of the absorber per one secondary particle (front view)



Residual dose on contact (vertical central slice)

Results

1. the Model of the absorber was created using the ROOT
2. the Model was successfully integrated in the MARS Code System
3. Simulations on 900 000 protons (2.4 mil secondary particles) carried out
4. Histograms of energy deposition and distribution of other quantities (residual dose., muon flux, total hadron flux) for various slices of the absorber obtained
5. Analysis of results has been started

Conclusions and Future goals

Conclusions

1. The absorber stops the beam and experiences high energy deposition in water-cooled blocks
2. Most of particles that don't absorb or produced inside fly behind the absorber
3. The absorber is safe for service stuff on sides, bottom and top of the structure (limited by statistics)
4. Preliminary results show that the absorber provides protection for the environment

Future goals

1. Increase statistics:
   - Increase the number of primary protons
   - GRID simulation on 100 computers
2. Obtain more information about processes in and out of the absorber: star density, residual dose rates, radioactive water system
3. Provide energy deposition for an additional ANSYS analysis